WHAT IS CLAIMED IS:

1. An isolated or purified antibody or antigenically-reactive fragment thereof that specifically binds to a C-terminal phosphorylated serine in an H2A histone protein.

2. The isolated or purified antibody or antigenically-reactive fragment thereof of claim 1, wherein said phosphorylated serine is about four amino acids from the C-terminus of said H2A histone protein.

3. The isolated or purified antibody or antigenically-reactive fragment thereof of claim 1, wherein the C-terminus of said H2A histone protein comprises the amino acid sequence SQ(D/E/A)(I/L/Y/F).

4. The isolated or purified antibody or antigenically-reactive fragment thereof of claim 1, wherein said antigenically-reactive fragment is selected from the group consisting of Fab, Fab', $F(ab')_2$, and F(v).

5. The isolated or purified antibody or antigenically-reactive fragment thereof of claim 1, wherein said H2A histone protein is mammalian.

6. The isolated or purified antibody or antigenically-reactive fragment thereof of claim 5, wherein said H2A histone protein is H2AX.

7. The isolated or purified antibody or antigenically-reactive fragment thereof of claim 1 or claim 3, wherein said antibody or fragment thereof is labeled with a means of facilitating detection.

8. The isolated or purified antibody or antigenically-reactive fragment thereof of claim 7, wherein said means of facilitating detection is an enzyme, a radioactive isotope, a fluorescent molecule, or biotin.

9. A product comprising an isolated or purified antibody or antigenically-reactive fragment thereof of any of claims 1-8.

10. A fusion protein comprising the isolated or purified antibody or antigenically-reactive fragment thereof of claim 1 or claim 3.

11. A method of determining double-stranded breaks in DNA, which method comprises: (i) contacting a sample comprising H2A histone proteins, wherein said H2A histone proteins are derived from or complexed with DNA, with an isolated or purified antibody or antigenically-reactive fragment thereof of claim 1, and (ii) detecting binding of said antibody or antigenically-reactive fragment thereof to an H2A histone protein in said sample, wherein the detection of said binding indicates the presence of double-stranded breaks in DNA.

12. The method of claim 11, wherein said antibody or antigenically-reactive fragment is labeled with a means of facilitating detection of said binding of said antibody or antigenically-reactive fragment thereof to said H2A histone protein.

13. The method of claim 12, wherein said means of facilitating detection is an enzyme, a radioactive isotope, a fluorescent molecule, or biotin.

14. The method of claim 11, wherein a labeled secondary antibody is used to detect binding of said antibody or antigenically-reactive fragment thereof to said H2A histone protein.

15. The method of claim 11, wherein said method further comprises quantifying the amount of double-stranded breaks in DNA.

16. The method of claim 11, wherein said method is used as a biological radiation dosimeter, which method further comprises (iii) assessing the extent of an organism's exposure to radiation by comparing the amount of DNA double-stranded breaks in said sample to standards exposed to a predetermined amount of radiation.

17. The method of claim 16, wherein said sample is obtained from said organism at from about 5 minutes to about 30 minutes after exposure of said organism to radiation.

18. The method of claim 11, wherein said method is used to determine the sensitivity of an organism to a mutagen or radiation and said sample is from an organism that has been exposed to a mutagen or radiation, which method further comprises (iii) assessing the rate of repair of DNA double-stranded breaks by repeating steps (i) and (ii) one or more times as necessary to assess the rate of repair of DNA double-stranded breaks.

19. The method of claim 11, wherein said method is used to determine homologous recombination or V(D)J rearrangement in DNA, wherein the detection of DNA double-stranded breaks is indicative of homologous recombination or V(D)J rearrangement in DNA.

20. The method of claim 11, wherein said method is used as an indicator of apoptosis and said sample is derived from cells, which method further comprises (iii) assessing the extent of apoptosis of said cells by comparing the amount of double-stranded breaks in DNA detected for said sample to a standard.

21. A method of determining whether or not cells in a cell sample are in the S phase of the cell cycle, which method comprises:

(i) obtaining a cell sample that has been exposed to bromodeoxyuridine (BrdU) followed by ultraviolet A (UVA) light in the presence of a compound that sensitizes DNA in said cell sample to said UVA light, and

(ii) detecting binding of an isolated or purified antibody of claim 1 or an antigenically-reactive fragment

thereof to an H2A histone protein in said cell sample, wherein the detection of said binding indicates the presence of double-stranded breaks in DNA and, therefore, the presence of cells in said cell sample that are in the S phase of the cell cycle.

22. The method of claim 21, wherein said cell sample is from a patient and said method is used to assess abnormal cellular proliferation in said patient.

23. A method of determining whether or not cells in a cell sample are in the S phase of the cell cycle, which method comprises:

(i) exposing a cell sample to bromodeoxyuridine (BrdU);

(ii) exposing said cell sample from (i) to ultraviolet A (UVA) light in the presence of a compound that sensitizes DNA to UVA light; and

(iii) detecting binding of an isolated or purified antibody of claim 1 or an antigenically-reactive fragment thereof to an H2A histone protein in said cell sample, wherein the detection of said binding indicates the presence of double-stranded breaks in DNA and, therefore, the present of cells in said cell sample that are in the S phase of the cell cycle.

24. The method of claim 23, wherein said cell sample is from a patient and said method is used to assess abnormal cellular proliferation in said patient.

25. A kit for determining DNA double-stranded breaks, wherein said kit comprises an isolated or purified antibody of claim 1 or claim 3 or an antigenically-reactive fragment thereof, and a means of detecting binding of said antibody or antigenically-reactive fragment thereof to an H2A histone protein.

26. A method of using the kit of claim 25, which method comprises the method of any of claims 11-24.